NOAA/NMFS
Southeast Fisheries Science Center
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Standard Operating Protocols for Pelagic Longline Surveys

U.S. Department of Commerce

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Southeast Fisheries Science Center

TABLE OF CONTENTS

Southeast Fisheries Science Center (SEFSC) Historical Overview of Pelagic Longline Surveys

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories (MSL) conducted pelagic longline surveys in both the U.S. Atlantic coast of the western North Atlantic Ocean (2004, 2006) and the Gulf of Mexico (Gulf) (2005). The primary objective of the initial surveys was to assess the feasibility of utilizing pelagic longline gear to assess the distribution and abundance of pelagic sharks and teleosts across their known or suspected ranges in order to develop a time series for trend analysis. Longline gear has been used for many years to study shark populations but many early U.S. surveys were directed in nature, and while providing information on presence and absence of shark and teleosts species at certain locations, the surveys were of limited value in determining trends over time. The fisheries-independent MSL surveys do not target specific species but have been confined by broad survey areas (e.g., east Gulf) and time of year (generally early to late spring).

Protocol 1: Survey Operational Procedures

A. Vessel requirements

Pelagic longline projects can be supported by a variety of vessels and the minimum vessel requirement for longline operations is defined by a vessel's hydraulic system capabilities or electrical power capabilities sufficient to run a self-contained longline reel/hydraulic reservoir system. Vessel length can be a concern since with larger vessels it is possible to support a wider variety of scientific objectives than with smaller vessels due

to work space and crew and scientist's accommodations. On a large vessel it is possible to remain at sea for longer periods and to work a full 24 hr work cycle, whereas on a smaller vessel it is generally not feasible to carry enough crew and scientists to support a 24 hr work cycle in addition to greater limitations for days away from port (limitations for provisions and bait supply). Smaller vessels are more prone to be affected by sea conditions, but on the other hand, they are more maneuverable than larger vessels and the shorter distance from the ship's deck to sea surface facilitates closer contact with large specimens brought alongside. SEFSC projects have been conducted from vessels ranging in length from 40-225 ft (12-67 m), with at sea endurance from 1-23 days.

B. Measure survey gear

Monofilament longline gear was selected for the projects as it is the preferred gear of the commercial fishing sector. An adequate-sized longline spool holds approximately 10 n. mi. of 4.0 mm diameter monofilament line (900-1200 lb test;401.8-535.7 kg test); the length of the longline set is 5 n. mi. determined after the first high flier buoy line is deployed to the beginning point of the last high flier buoy line deployed. Radar reflecting buoys are used to mark longline locations at start, middle, and end of line. Two gangions (100 per set) are attached between each bullet float (50 per set). Bullet float drop lines (18.3 m, 10 fm) and gangions are attached to the mainline. Gangions (22 m length) are constructed with #18/0 non-offset steel circle hooks baited with Atlantic mackerel *(Scomber scombrus*; 11 kg or 25 lb of bait are used for a 100 hook set with bait size cut to fit hooks) with a 0.5 m length of multistrand stainless steel fishing wire (364 kg breaking strength) attached between the hook and a 60 g weighted swivel. The 21.5 m length of gangion monofilament (2.0 mm diameter, 179 kg test or 400 lb test) connects the weighted swivel with the gangion mainline clip. Gangions are numbered sequentially with numeric tags. Longline gear is fished for 3 hr (determined as the time duration between deployment of the last longline set high flier buoy to retrieval of the first longline haulback high flier buoy to begin haulback).

Because of the constant cutting and reattachment of the mainline and potential loss of sections of line over the course of a survey, the mainline is not marked in sections and the length of mainline deployed is based on GPS intervals. Provided the vessel has Scientific Computing System (SCS)/Fisheries Scientific Computing System (FSCS) capabilities, longline component attachments can be monitored by specialized software operated from on-deck weatherproof laptop computers during both the gear set and haulback. Using the laptop computers also allows for per-hook monitoring of effort, bait status (e.g., damaged, missing), gear status (e.g., damaged), catch status (capture) and other general comments that help characterize the gear haul. Additionally, if the gear haulback needs to be modified (e.g., a reverse gear haulback direction or the line parts and a different gear retrieval order is needed) the FSCS software is adaptable for recording gear haulback irregularities. Hook timers and time-depth-temperature devices can be optionally added per hook and accounted for with FSCS based software.

C. Longline set and haulback events

To properly calculate catch per unit effort (CPUE) and a variety of additional statistical analyses, it is important to document longline set, gear soak and longline haulback events. There are 4 critical events; first high flier deployed (beginning of the set), last high flier deployed (end of the set), first high flier retrieved (beginning of haulback) and last high flier retrieved (end of haulback). Minimum data elements required for each event are the date, time, bottom depth, latitude and longitude.

To begin longline deployment, the mainline is attached to a high flier (radar reflecting buoy) and at least 18.3 m (10 f) of mainline monofilament is deployed. To assure the mainline settles at fishing depth a weight is then attached to the mainline immediately followed by hard float attached to the mainline with an 18.3 m float drop line (float drop lines and gangions are deployed and retrieved with a hand cranked dual-bin spool). After the hard float with the float drop line is attached the first gangion is attached to the mainline; gangion and bullet float spacing is determined by GPS (i.e., at 1 n. mi. after the first high flier/weight/hard float attachment 20

evenly spaced gangions and 10 bullet floats are deployed; the order is 2 gangions followed by 1 bullet float attached with a float dropline) and n. mi. increments are relayed to the gear set crew from the bridge by hand-held 2-way radios or are determined from a weatherproof laptop equipped with GPS. An electronic beeper (interval based on vessel speed) is often used to determine component attachment intervals. The gear set continues until the entire 5 n. mi. of mainline has been deployed with 100 gangions and 50 bullet floats (an additional high flier with an additional weight is attached at mid set). Weights (5-10 kg) are attached to the beginning, middle and end of the longline set to prevent gear from rising in the water column. After the end hard float (with float dropline) and weight is attached to the mainline, enough mainline is deployed (at least 18.3 m) for the set terminal high flier buoy attachment. The gear haulback direction is typically the same as the set direction; the first high flier buoy set is the first high flier buoy retrieved (that is subject to change to accommodate changing weather or current conditions). Prior to the gear haulback, the mainline is reattached to the remaining line on the spool.

D. Set duration and length of longline deployed

Standard sets are 3 hr in duration with 100 hooks attached along 5 n. mi. of mainline. There are a number of situations that can affect the haulback duration including; high catch rates where data reporting requirements and tagging necessitate slowing the retrieval process, large fish entangling gangions and other gear components, and sea turtle encounters. If the haulback is delayed, some of the hooks deployed near the end of the set soak for more than the 3 hr standard. However, since the time event is recorded for the final high flier brought aboard to end the haulback, extended haulback times are documented.

Gear soak time is an important element in calculating fishing effort (CPUE, expressed as the number of captures by species/100 hook hr). Soak time is defined during SEFSC surveys, and often for other surveys, as the time between deployment of the last high flier to end the set to the time of retrieval of the first high flier to begin haulback. Since the beginning and end of the soak period are essential data elements, soaks that deviate from the standard 3 hr can be accounted for during data analysis. It is possible to use critical events for re-evaluating effort calculations if needed since the 4 critical events are data elements (begin set, end set, begin haulback and end haulback). Additionally, provided a project is conducted aboard a research vessel equipped with SCS/FSCS, it may be possible to monitor effort, gear and catch on a per hook basis by using weatherproof laptop computers. SEFSC/MSL maintains customized software (SELLIT) needed for complete gear and catch monitoring.

E. Direction of sets

Ideally, sets are made into the prevailing winds or currents. Gear is set from the stern of the vessel and communications between the deck crew and helmsman are maintained via hand held two-way radios. Set procedures are generally standard and should be maintained for consistent effort. Primary set procedures and events include; wheel house to deck notification of the set event, deploying the first high flier, attachment of the first weight and hard float, attaching gangions and bullet floats at approximately equidistant increments, attachment of the mid-weight and mid-high flier, completing gangion and bullet float deployment, attaching the last hard float and weight, and deploying the last high flier to mark the set termination point.

F. Bottom topography

For pelagic longline projects bottom topography is not often a concern, but for pelagic longline sets made relatively close to the continental shelf edge caution must be exercised to not entangle gear with sea bottom. Research and charter vessels are, as a rule, equipped with echo sounders suitable for providing an electronic view of bottom profiles. Using an echo sounder to assess bottom type is often complicated by a number of factors that include bottom depth, bottom type (soft bottom verses hard bottom), sea conditions, vessel speed across bottom and echo sounder settings. It is recommended that experienced ship helmsmen operate echo sounders since a number of variables may affect generated displays.

G. Location of sampling sites and procedures to use if a station must be relocated

For circumstances where there is a prohibitive feature for gear deployment (a fixed platform, restricted fairway, vessel traffic), a SEAMAP survey protocol was established to allow for movement of a pre-selected station 0.5 n. mi. in any direction from the originally selected point provided a newly selected point does not fall outside of the predetermined sampling strata (if designated). For most surveys this is generally sufficient for relocating a set. For those cases when a 0.5 n. mi. search does not provide an alternative set location, after discussion between the helmsman and the watch leader or Field Party Chief, the station is dropped. A new location may be selected through a predetermined randomization procedure that follows the criteria of the original survey design.

H. Gear damage and repeat criteria

Gear damage can lead to lost survey time. Often gear damage can be minimized by maintaining proper set direction and maintaining proper vessel orientation during haulback (e.g., caution not to tangle the line in the propeller). However, gear damage can occur even during the best of circumstances. Notations concerning gear damage are made in the data sheet comment section and are a matter of record for associated data. Data collected from sets with gear damage is not disregarded. If gear damage was a result of a problem with gear deployment (e.g., the mainline breaks during the set) the set is repeated if the set cannot be continued.

I. Criteria for determining the success of a pelagic longline set and procedures to use if a set was unsuccessful

A fully successful pelagic longline set is a scenario where established protocols were followed throughout the set and during haulback there were no indications of damage or fouling of the mainline, gangions or hooks. Longline sets that are considered less than successful are those where less than the full set of 100 hooks are retrieved or components of the longline gear were damaged or lost. Less than successful sets are not repeated but the number of hooks retrieved and any associated problems are noted as comments associated with longline data. The only scenario where an unsuccessful set would be repeated is when an unsuccessful set was the result of a correctable oversight by the set crew (e.g., bottom weights not used or adequate buoy line not deployed).

J. Gear and bait preparation

Gear and bait preparations are completed before arrival at the set location. Gangions and hooks are inspected for damage and baited with relatively uniform sized bait pieces suitable for the survey hook type. SEFSC surveys use a single bait type (i.e., Atlantic mackerel) to minimize variability attributable to bait; bait pieces are cut to properly fit the hook without being excessively large or small. When possible, baits are double hooked by passing the hook barb twice through each bait piece. Typically, 11 kg (25 lb) of bait is sufficient for a 100-hook set.

K. Vessel and winch operation during set deployment and retrieval

Vessel speed while deploying the longline is 9.2 km/hr (5 kt). The ship's GPS is used to measure the 5 n. mi. set that begins when the first pelagic longline weight is attached to the mainline; the 5 n. mi. set terminates after the last longline weight is attached. The high flier buoy lines are not included in the 5 n. mi. measure. Communications between the ship's helmsmen and set crew are maintained via hand-held two-way radios. Gear haulback speed can vary from 0-5 kt depending on sea conditions and the number of captures. Often the capture of large specimens or numerous captures necessitates a slowing or stopping of the vessel.

L. Defining Responsibility

The Field Party Chief for bottom longline surveys is responsible for preparing survey instructions, assembling the scientific complement, handling logistics for loading gear and bait deliveries, and selecting stations. Station locations are made available to vessel command at least one month prior to surveys. Daily scientific operations, sampling procedures and routine gear maintenance (preparing the gear for the set) are the responsibility of the watch leader. The Field Party Chief or watch leader participates in discussions with the ship helmsman or other

officer on watch concerning the feasibility of conducting longline operations when a predesignated location may need to be moved due to ship traffic, fixed platforms or presence of prohibitive bottom features.

M. Survey Design

The locations for longline sets are chosen at random and are not directed sampling based on capture of a particular elasmobranch or teleost. A random number generator (with replacement) is used to first generate a random line of latitude or longitude with the second coordinate a random distance from shore or the continental shelf edge. Past SEFSC pilot study surveys employed randomly selected stations that were proportionally allocated based on the area within 60 n. mi. (of latitude or longitude) sampling zones, or station locations were allocated within zones that were dependent on oceanographic features (Gulf Stream location or proximity of significant loop current features). Stations are not designated day or night stations but are occupied opportunistically with minimum steaming time between stations. Gear is fully deployed, allowed to soak for 3 hr (the time after the last buoy deployment during the set and the retrieval of the first buoy to begin the gear haul). Catch data are collected as catch comes aboard during the haul or after the haul is complete for catch that needs to be biologically sampled.

N. Biological Data Elements

Biological data collected for captures generally follows established SEAMAP protocols and includes (but is not limited to); total length, fork length, standard length (optional but often collected for reef fish species), precaudal length for sharks, sex, reproductive development stage and whole weight. Specimen photographs that are catalogued with station number identifiers (or even specific hook numbers) are valuable for confirming identifications. Tagging is an important component of longline studies and a data format for including a tag number for a particular capture is essential. Often biological sampling of specimens is required and data sheets and data entry formats facilitate sample tracking.

During current MSL surveys on NOAA ships, a computerized data collection system allows monitoring of survey events. Collecting biological and associated data with NOAA ship SCS and NMFS FSCS creates a wider and more accurate range of survey data options. Many data elements (in particular gear events) can be collected in real time with weatherproof laptop computers that are either hard wired via network ports or use WiFi transmission to the ship's primary computer server. Utilizing the ship's SCS data allows Greenwich Mean Time (GMT) time/date stamps and the corresponding position (latitude/longitude) to be associated with set and haulback events (e.g., buoy and gangion deployments and retrieval, hook status, catch status). FSCS biological data collection options accommodate a full range of biological elements needed to describe species landed (i.e., lengths, weights, tagging information, special sampling) and can be used in real time as catch is landed or for sampling after the gear haulback is completed. Edit routines are useful for identifying potential data problems. The SCS/FSCS data are edited and archived with ACCESS software. If Time-Depth-Recorders (TDRs) are used, TDRs are sequentially numbered to match the numbered gangions and TDRs are downloaded if there was a capture, or once weekly to clear memory. TDRs are typically attached 1–2 m above the hook in proximity to the weighted swivel. TDR files are named with the convention to match specimen numbers (vessel code/survey number/station number/hook number). If hook timers are used they are attached between the gangion and mainline.

Use of a catch landing sling (operated with hydraulic cranes) facilitates accurate length and weight measurements for catch that typically would be too large to land. The 3 m length landing sling (constructed with a stainless steel frame and mesh-panel landing basket) can be used to haul large specimens to the ship's rail or onboard for collection of biological data, conduct accurate tagging, and for tissue sampling. The landing sling is equipped with a remotely controlled electronic scale with digital readout and output port. The landing sling can be used aboard larger research platforms and requires little or no vessel modifications.

Protocol 2: Pelagic Longline Gear Construction, Repair and Maintenance

Pelagic Longline gear components and repair

Pelagic longline gear is useful for assessing a variety of fishery issues. Whether target species are large elasmobranchs or small teleosts, pelagic longline gear components and survey strategies can be modified to suit survey objectives. For surveys using pelagic longline gear, standardization of operation protocols (for specific projects) is desirable in order to compare time series data between surveys or across years. Gear standardization is relatively uncomplicated provided survey design parameters and gear components are properly documented. Data elements that describe longline sets should include pertinent gear specifics (i.e., number of hooks and hook type).

Longline gear is typically deployed and retrieved with a hydraulic longline reel. Pelagic longline gear typically consists of monofilament mainline, monofilament gangions (monofilament leaders with 0.5 multistrand steel leaders, and AK snaps for attaching gangions to the mainline and hooks attached with crimps), monofilament blocks, a rail roller or line retrieval block, high fliers, polyball floats, hard floats, bullet floats, and weights.

Reel, blocks, and rollers

The longline reel is either connected to the vessel's hydraulics or may be equipped with a self-contained hydraulic unit. Mainline is spooled onto the reel prior to sailing. Mainline may be deployed or retrieved through monofilament blocks; sometimes a roller mounted on the ship's cap rail is used for retrieval. If the position of the longline reel is not optimal, the mainline may then be redirected by the use of a series of monofilament blocks to the point of setting or haulback. A general rule concerning use of blocks is the fewer the blocks used the less likely it will be that the mainline monofilament will twist or snag. The longline reel, rail roller, and blocks should be inspected and greased regularly and protected from the elements when not in use.

Mainline

Factors that affect the choice of mainline test strength for pelagic longline surveys include target species size, and vessel specifics and maneuverability. SEFSC pelagic longline surveys use 4.0 mm diameter monofilament mainline and 900-1200 lb (401.8–535.7 kg) test monofilament mainline due to the capture of large elasmobranchs and teleosts. Mainline should be inspected regularly for damage and replaced in sections or in its entirety as needed. Sections of mainline can be joined using appropriately-sized metal crimping sleeves and a hand-held crimping tool on the appropriate setting, or joined with specialized knots (blood knots). Care should be taken to ensure that crimps are neither too loose (line will pull through) or too tight (sleeve will cut into line and reduce strength under tension). Monofilament mainline should be protected from light exposure when not in use.

Gangions

For SEFSC pelagic longline surveys, gangions (22 m total length) are constructed with 2.0 mm diameter monofilament (179 kg test; 21.5 m length), AK snaps for attaching gangions to the mainline, multistrand steel leaders (0.5 m length) between the hook and a weighted 60 g swivel, #18/0 non-offset steel circle hooks and crimping sleeves. A sufficient number of gangions should be assembled prior to sailing to allow for 2 full sets of gear (for SEFSC pelagic longline surveys, 200 gangions). Gangions should be inspected after each set for signs of wear or damage to monofilament, weakening of AK snaps, and bent or damaged hooks. Sleeves should be crimped using the appropriate setting on the crimping tool to avoid crimps that are either too loose or too tight.

High fliers

High fliers are used at the beginning, middle and end of each set and are comprised of diamond-shaped radar reflectors (metal or plastic) attached to the end of a buoy pole (typically 12-15 ft; 3.6–4.5 m length) which passes through a center through-hole in an inflatable polyball float. High fliers are weighted at the bottom with

metal counter weights to ensure that they remain upright in the water. Reflective tape is placed on the radar reflector and during inclement weather and at night, battery-operated strobe lights are attached to the pole near the radar reflector. For the first and last high flier the high flier assembly is tethered to an additional polyball float to facilitate recovery during haulback. Monofilament and snaps connecting elements of the high flier assembly should be checked regularly for wear, particularly when monofilament is used to connect weights to the high flier pole. Strobe lights should be checked daily and batteries changed as needed.

Weights

Weights (5 – 10 kg) are used at the beginning, middle, and end of each set (in conjunction with high fliers) to keep the mainline at uniform depth. Monofilament and AK snaps used to attach weights to the mainline should be inspected daily for wear and damage.

High Flier Buoy lines

High flier buoy lines used to attach high fliers to the distal ends of a bottom longline set are simply additional mainline monofilament deployed at the beginning and end of the longline set; the exception is the mid-set high flier buoy line that needs to be a separate component 18.3 m length (this is one of the float droplines). At the beginning of a set, the high flier is fastened to the mainline and deployed, then at least 18.3 m of monofilament mainline is deployed before the first down weight is attached. At the set termination, after the last down weight is attached at least 18.3 m of mainline is deployed to create the end set high flier buoy line then the terminal set high flier buoy is attached; the mainline is cut and the high flier buoy is deployed.